Diversification and bank stability

Diversification and Bank Stability

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Abstract

This paper tests a theory in the literature regarding the role of diversification in bank systemic risk and investigates whether this effect is different for bank standalone risk. We innovatively construct a country-level diversification measure to capture the risk distribution among banks. Based on a large dataset consisting of 1,346 international publicly listed banks from 49 countries from 1998 to 2018, our results confirm existing theoretical conclusions that higher diversification leads to more systemic risk and less bank standalone risk.

Keywords: country-level diversification; idiosyncratic risk; systemic risk

JEL Classification: G20; G21

1 Introduction

Wagner (2010) proposes a model arguing that diversification at financial institutions makes systemic crises more likely since a higher diversification makes institutions exposed to common risks through holding similar portfolios, although diversification reduces each institution's standalone risk. This theory has received considerable attention because it provides a novel insight into bank systemic risk by identifying a mechanical reason for the adverse effect of diversification even under "normal circumstances." Nevertheless, this theory has not been empirically tested yet in the context of banking due to the challenge in constructing a diversification measure that can reflect the mechanism in which diversification influences risk. By innovatively building up a country-level diversification measure, we test the impact of diversification on both systemic and standalone risk[1], based on a dataset consisting of 1,346 international publicly listed banks from 49 countries from 1998 to 2018. Our country-level diversification indicator utilizes revenue data of individual banks in a country, and implicitly reflects the risk distribution among banks through capturing the distribution of banks' revenues. This characteristic makes our empirical analysis more appropriate to test the mechanical reasons of Wagner (2010) than other studies that employ traditionally used bank-level diversification indicators (Mercieca et al., 2007; Laeven and Levine, 2007; Elsas et al., 2010). Our results confirm that an increase in diversification in a country leads to more systemic risk while reducing bank idiosyncratic risk.

2 Data and Methodology

We retrieve accounting information from Worldscope to construct our diversification indicator and bank-specific variables, and obtain stock price information from CRSP, Datastream and Compustat Global to compute market-based indicators.

[1] We define "bank risk" as the opposite of "bank stability".

To investigate the effect of diversification on bank stability, we employ the fixed effects model to control for unobserved time-invariant bank- and country-specific fixed effects and year fixed effects. The model is specified as follows:

$$bank\ risk_{i,j,t} = \alpha + \beta \times\ diversification_{j,t-1} + \delta_1 \times bank\ specific\ controls_{i,j,t} + \delta_2 \times macroeconomic\ controls_{j,t} + \mu_i + \nu_j + \tau_t + \varepsilon_{i,j,t}$$

where subscripts i, j and t denote bank i in country j in year t. $bank\ risk_{i,j,t}$ represents bank systemic ($\Delta CoVaR$) or idiosyncratic risk (*Z-Score*) measures. $diversification_{j,t-1}$ denotes the country-level revenue diversification measure (*CRD*).[2] We use time lagged values of the diversification indicator to mitigate the issue of reverse causality from bank risk to diversification. Bank-specific control variables include bank-level diversification (*RD*), bank size, capitalization, non-performing loans, loan growth ratio, deposit ratio and loan ratio. *RD* is included to control for the possibility of biased information on the degree of diversification in a country since *CRD* does not reflect the distribution of interest and non-interest incomes within each bank.[3] Macroeconomic variables include GDP growth rate, GDP per capita and inflation rate. μ_i, ν_j and τ_t capture bank, country and year fixed effects, respectively. $\varepsilon_{i,j,t}$ is the error term.

3 Results and Discussions

Table 1 shows our results concerning the relationship between country-level diversification and bank stability in the dimensions of idiosyncratic and systemic risk. We employ both fixed effects estimations and two-stage least square (2SLS) regressions in order to confirm that our

[2] Detailed calculations of *CRD* and *RD* are shown in the Appendix.

[3] Consider two extreme situations regarding the distributions of interest and non-interest revenues of two banks in a country. In the first situation, one bank is fully concentrated on interest incomes while the other one is concentrated on non-interest incomes. In the second situation, the distribution of revenues of these two banks is perfectly balanced between interest and non-interest revenues. The values of country-level diversification would be the same under these two extreme situations according to our specification. Therefore, it is necessary to include the bank-level diversification into the regressions to distinguish these two situations.

findings are consistent and less subject to the endogeneity problem. According to the results of the fixed effects estimation, the significant positive coefficients of country-level diversification in columns (1) and (2) indicate that diversification is negatively associated with bank idiosyncratic risk.[4] This finding could be explained by the modern portfolio theory given that a firm's idiosyncratic risk can be reduced by holding a well-diversified portfolio (Markowitz, 1952; Sharpe, 1964). In contrast, we find significant negative coefficients of *CRD* in the dimension of system risk in columns (3) and (4).[5] These findings provide empirical evidence in line with the theory of Wagner (2010) according to which diversification makes systemic crisis more likely since diversification tends to increase the similarity across banks in terms of activities or portfolios as they become more exposed to common risks. These results suggest that the degree of diversification in a country may lead to different effects on bank idiosyncratic and systemic risk.

We further run IV-2SLS regressions to check the consistence of our results. We use the Diversification Index as an instrument for *CRD*. The Diversification Index is a variable constructed based on two survey questions from the Bank Regulation and Supervision Survey,[6] and this index shows whether there are any regulatory rules or supervisory guidelines regarding assets diversification and whether banks can make loans abroad. We expect a positive association between the Diversification Index and the diversification indicator used in our study.[7] Based on the second-stage results, we find consistent significantly negative relationship between diversification and idiosyncratic risk in columns (5) and (6) and a positive relationship in the dimension of systemic risk in columns (7) and (8).

[Insert Table 1 around here]

[4] The value of Z-Score is inverse to idiosyncratic risk.
[5] The value of ΔCoVaR is inverse to systemic risk.
[6] This database can be accessed through the website: https://www.worldbank.org/en/research/brief/BRSS.
[7] The F-statistics of the first-stage results of the 2SLS regressions reject the hypothesis that the coefficients of instrumental variables are zero, which indicates the relevance of our instruments with respect to the endogenous variable. Detailed results are available upon request.

4 Robustness check

To test whether our results hold for different specifications of the diversification indicator, we construct an alternative county-level diversification measure, country-level income diversity (*CID*). Following Laeven and Levine (2007), we first construct the bank-level income diversity (*ID*) for each bank, and then we build up this indicator at the country level to capture the overall degree of diversification in a country. We find consistent results in Table 2 with our baseline results showing that the overall degree of income diversity in a country has significant negative impact on bank systemic stability (columns 3, 4, 7 and 8) and positive impact on individual bank stability (columns 1, 2, 5 and 6).

[Insert Table 2 around here]

5 Conclusion

This paper provides empirical support to test theoretical arguments indicating a negative impact of diversification on bank systemic stability, and further examines whether this effect is different for idiosyncratic risk. Our results confirm previous theoretical claims that an increase in diversification leads to more systemic risk contributions of banks, which is possibly due to higher similarities of activities and portfolios among banks as diversification grows. Our results also confirm that diversification reduces bank idiosyncratic risk.

References

Elsas, Ralf, Andreas Hackethal, and Markus Holzhäuser. "The anatomy of bank diversification." *Journal of Banking and Finance* 34.6 (2010): 1274-1287.

Laeven, Luc, and Ross Levine. "Is there a diversification discount in financial conglomerates?" *Journal of Financial Economics* 85.2 (2007): 331-367.

Markowitz, Harry. "Portfolio selection." *Journal of Finance* 7.1 (1952): 77-91.

Mercieca, Steve, Klaus Schaeck, and Simon Wolfe. "Small European banks: Benefits from diversification?" *Journal of Banking and Finance* 31.7 (2007): 1975-1998.

Sharpe, William F. "Capital asset prices: A theory of market equilibrium under conditions of risk." *Journal of Finance* 19.3 (1964): 425-442.

Wagner, Wolf. "Diversification at financial institutions and systemic crises." *Journal of Financial Intermediation* 19.3 (2010): 373-386.

Appendix

A. Calculation of country-level diversification measure

The bank-level diversification (*RD*) and the country-level diversification (*CRD*) are computed as follows:

$$RD_{i,t} = 1 - \left[\left(\frac{INT_{i,t}}{TOP_{i,t}} \right)^2 + \left(\frac{NON_{i,t}}{TOP_{i,t}} \right)^2 \right]$$

$$CRD_{j,t} = 1 - \left[\left(\frac{\sum INT_{i,t}}{\sum TOP_{i,t}} \right)^2 + \left(\frac{\sum NON_{i,t}}{\sum TOP_{i,t}} \right)^2 \right]$$

where subscripts *i*, *j* and *t* denote bank *i*, country *j* and year *t*. $INT_{i,t}$ is interest income and $NON_{i,t}$ is non-interest income. $TOP_{i,t}$ is total operating income, $TOP_{i,t} = INT_{i,t} + NON_{i,t}$. A high value of country-level revenue diversification (*CRD*) indicates a high degree of diversification between interest and non-interest activities.

B. Calculation of alternative country-level diversification measure

$$CID_{j,t} = 1 - \left| \frac{\sum Interest\ Income_{i,t} - \sum Other\ Operating\ Income_{i,t}}{\sum Total\ Operating\ Income_{i,t}} \right|$$

Table 1. The relationship between diversification and bank stability

Dependent Variables	*Z-Score*	*Z-Score*	Δ*CoVaR*	Δ*CoVaR*	*Z-Score*	*Z-Score*	Δ*CoVaR*	Δ*CoVaR*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Fixed effect estimation				*IV-2SLS*			
CRD	3.673***	3.360***	-0.00980***	-0.000610**	47.62***	15.10*	-1.104***	-0.0161**
	(0.808)	(0.687)	(0.00279)	(0.000265)	(6.946)	(8.714)	(0.0817)	(0.00770)
RD	-3.808***	-5.483***	0.0220***	-0.000314	-12.26***	-6.914***	0.244***	0.00244
	(0.827)	(0.819)	(0.00549)	(0.000546)	(1.647)	(1.736)	(0.0223)	(0.00153)
Bank Size	-0.611**	-1.908***	0.0249***	-6.96e-05	-0.536***	-1.859***	0.0250***	-8.71e-05
	(0.259)	(0.301)	(0.00125)	(0.000133)	(0.153)	(0.171)	(0.00200)	(0.000164)
Capitalization	0.576	0.766	-0.00456	-1.25e-05	0.399	0.645*	0.00821	0.000126
	(0.680)	(0.640)	(0.00566)	(0.000129)	(0.339)	(0.345)	(0.0111)	(0.000151)
NPL	-3.759*	-7.435***	0.0351**	0.000647	-10.61***	-10.97***	0.220***	0.00273*
	(2.111)	(1.998)	(0.0155)	(0.000902)	(1.917)	(1.960)	(0.0245)	(0.00163)
Loangrowth	-0.302	-0.0314	-0.00321**	9.84e-05	-0.423*	-0.147	0.00234	8.66e-06
	(0.217)	(0.216)	(0.00134)	(0.000196)	(0.237)	(0.221)	(0.00321)	(0.000194)
Loan	0.944	2.209**	-0.0326***	-0.000541	0.277	1.848***	-0.00628	2.92e-05
	(1.016)	(1.064)	(0.00595)	(0.000426)	(0.718)	(0.692)	(0.00914)	(0.000523)
Deposit	-8.016***	-11.99***	0.0438***	0.000540	-9.430***	-12.17***	0.0911***	0.000752
	(1.410)	(1.405)	(0.00851)	(0.000474)	(0.881)	(0.806)	(0.0120)	(0.000578)
GDPgrowth	13.71***	14.31***	0.164***	0.00529**	38.59***	14.83***	-0.302***	0.0110***
	(2.528)	(4.015)	(0.0126)	(0.00215)	(4.542)	(4.265)	(0.0597)	(0.00415)
GDPpercap	7.673***	1.029	0.104***	5.29e-05	10.03***	-0.766	-0.0117	-0.00171
	(1.011)	(1.249)	(0.0102)	(0.000498)	(0.914)	(1.067)	(0.0125)	(0.00107)
Inflation	-0.949	-1.296	0.0804***	0.00378***	4.130*	-1.825	-0.166***	0.00563***
	(1.790)	(1.619)	(0.0157)	(0.00138)	(2.408)	(1.464)	(0.0455)	(0.00184)
Constant	-39.19***	49.86***	-1.501***	-0.117***				
	(8.267)	(11.65)	(0.0929)	(0.00460)				
Number of Observations	16,901	16,901	16,018	16,018	15,219	15,219	14,473	14,473
Number of Banks	1,346	1,346	1,342	1,342	1,317	1,317	1,317	1,317
R-squared	0.040	0.079	0.342	0.993	-0.376	0.047	-6.102	0.990
Bank fixed effect	YES	YES	YES	YES	YES	YES	YES	YES
Country fixed effect	YES	YES	YES	YES	YES	YES	YES	YES
Year fixed effect	NO	YES	NO	YES	NO	YES	NO	YES
Kleibergen-Paap Wald rk F-statistic					245.95***	39.42***	210.48***	38.50***

Notes: This table reports regression results of the fixed effect estimation in columns (1)-(4) and the IV-2SLS by employing the Diversification Index as the instrument for *CRD* in columns (5)-(8). Robust standard errors are reported in parentheses below the coefficient estimates and clustered at the bank level. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table 2. Robustness check: The relationship between income diversity and bank stability

Dependent Variables	*Z-Score*	*Z-Score*	Δ*CoVaR*	Δ*CoVaR*	*Z-Score*	*Z-Score*	Δ*CoVaR*	Δ*CoVaR*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Fixed effect estimation				*IV-2SLS*			
CID	0.989***	0.981***	-0.00389***	-0.000130*	28.04***	6.858*	-0.633***	-0.00688**
	(0.255)	(0.202)	(0.000792)	(6.68e-05)	(4.054)	(3.759)	(0.0533)	(0.00334)
ID	-2.648***	-3.778***	0.0124***	-0.000158	-8.277***	-4.637***	0.147***	0.00111
	(0.406)	(0.411)	(0.00280)	(0.000288)	(1.057)	(0.814)	(0.0170)	(0.000738)
Controls	YES	YES	YES	YES	YES	YES	YES	YES
Number of Observations	16,901	16,901	16,018	16,018	15,219	15,219	14,473	14,473
Number of Banks	1,346	1,346	1,342	1,342	1,317	1,317	1,317	1,317
R-squared	0.042	0.084	0.342	0.993	-1.496	0.007	-20.272	0.989
Bank fixed effect	YES	YES	YES	YES	YES	YES	YES	YES
Country fixed effect	YES	YES	YES	YES	YES	YES	YES	YES
Year fixed effect	NO	YES	NO	YES	NO	YES	NO	YES
Kleibergen-Paap Wald rk F-statistic					181.64***	35.02***	156.79***	34.92***

Notes: This table reports regression results of the fixed effect estimation in columns (1)-(4) and the IV-2SLS by employing the Diversification Index as the instrument for *CID* in columns (5)-(8). Robust standard errors are reported in parentheses below the coefficient estimates and clustered at the bank level. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.